DOE-0333-FP/VA
Revision 0

Hanford Regulatory Experience

Regulation at Hanford - A Case Study

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

United States Department of Energy
P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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Regulation at Hanford - A Case Study

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Regulation at Hanford – A Case Study

Abstract

Hanford has played a pivotal role in the United States' defense for more than 60 years, beginning with the Manhattan Project in the 1940s. During its history, the Hanford Site has had nine reactors producing plutonium for the United States' nuclear weapons program. All the reactors were located next to the Columbia River and all had associated low-level radioactive and hazardous waste releases. Site cleanup, which formally began in 1989 with the signing of the *Hanford Federal Facility Agreement and Consent Order*, also known as the Tri-Party Agreement, involves more than 1,600 waste sites and burial grounds, and the demolition of more than 1,500 buildings and structures. Cleanup is scheduled to be complete by 2035. Regulatory oversight of the cleanup is being performed by the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) and the *Revised Code of Washington*, "Hazardous Waste Management."

Cleanup of the waste sites and demolition of the many buildings and structures generates large volumes of contaminated soil, equipment, demolition debris, and other wastes that must be disposed of in a secure manner to prevent further environmental degradation. From a risk perspective, it is essential the cleanup waste be moved to a disposal facility located well away from the Columbia River. The solution was to construct a very large engineered landfill that meets all technical regulatory requirements, on the Hanford Site Central Plateau approximately 10 kilometers from the river and 100 meters above groundwater. This landfill, called the Environmental Restoration Disposal Facility or ERDF is a series of cells, each 150 x 300 meters wide at the bottom and 20 meters deep.

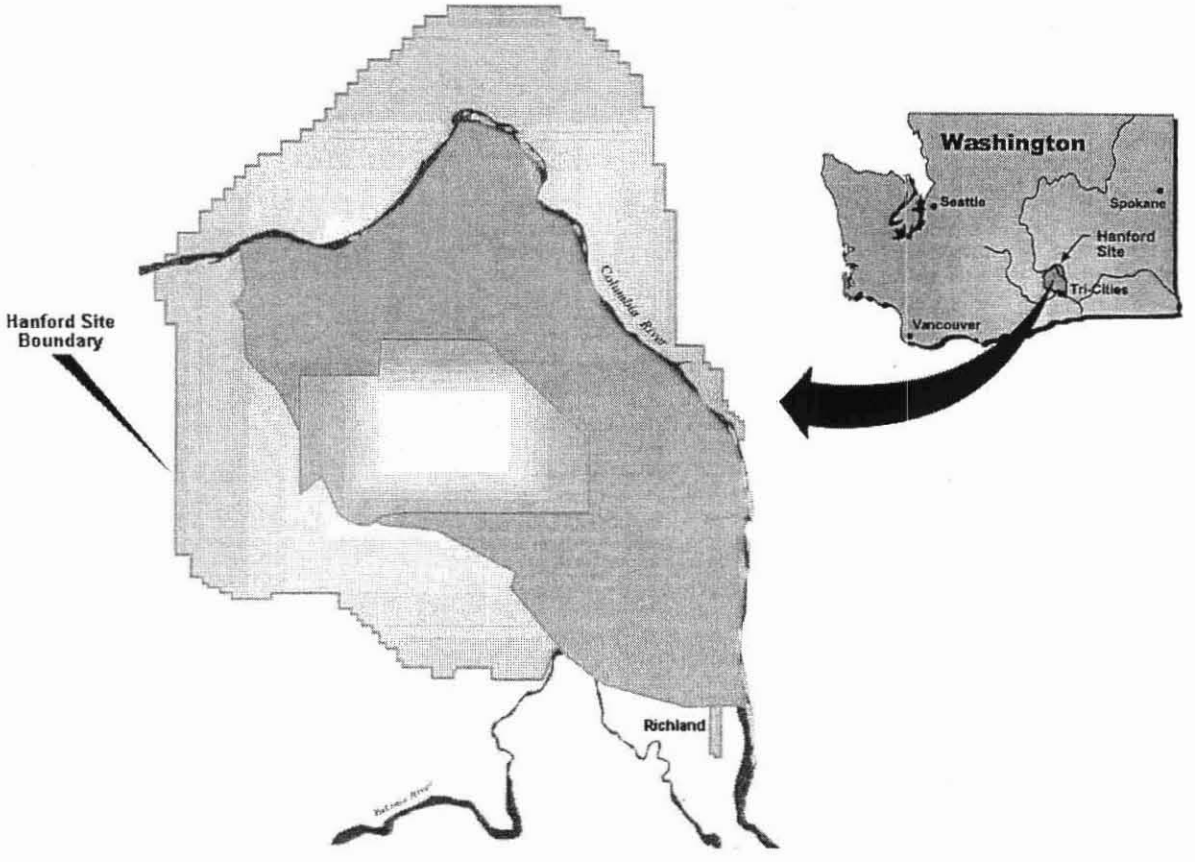
This paper looks at the substantive environmental regulations applied to ERDF, and how the facility is designed to protect the environment and meet regulatory requirements. The paper describes how the U.S. Department of Energy (DOE), EPA, and Ecology interact in its regulation. In addition, the response to a recent $1 million regulatory fine is described to show actual interactions and options in this aspect of the regulatory process.

The author acknowledges the significant contributions by Messrs. Clifford Clark and Owen Robertson. Ms. Nancy Williams provided graphics support and Ms. Laurie Kraemer edited the report.

1.0 THE HANFORD SITE

In 1943, the Hanford Site was chosen for plutonium production as part of the Manhattan Project due to its sparse population, remote location, and abundant water supply. The site occupies 586 square miles (1,518 square kilometers) in Benton County, located in south-central Washington. The Columbia River forms the site's eastern boundary (Figure 1).

Figure 1 – Hanford Site Location



Currently, the Hanford Site is engaged in the largest environmental cleanup effort in the United States. The United States halted plutonium production in the late 1980s when the N-Reactor and PUREX (Plutonium Uranium Extraction) plant ceased operations. In 1989, DOE, EPA, and Ecology signed the *Hanford Federal Facility Agreement and Consent Order* (also called the Tri-Party Agreement). This agreement includes the basic plan and schedule to bring the site into environmental regulatory compliance while cleaning up Hanford's legacy waste (Table 1).

Table 1 – Legacy Material

Richland Operations Office

- 2,300 tons nuclear fuel
- Several tons of plutonium
- About 270 billion gallons of contaminated groundwater, covering about 80 square miles
- About 25 million cubic feet of buried or stored solid waste in 175 waste trenches
- More than 1,600 waste sites and 1500 facilities (many contaminated), including 5 processing "canyon" facilities and 9 reactor complexes
- 1,936 capsules of cesium and strontium, containing about 109 million curies of radioactivity

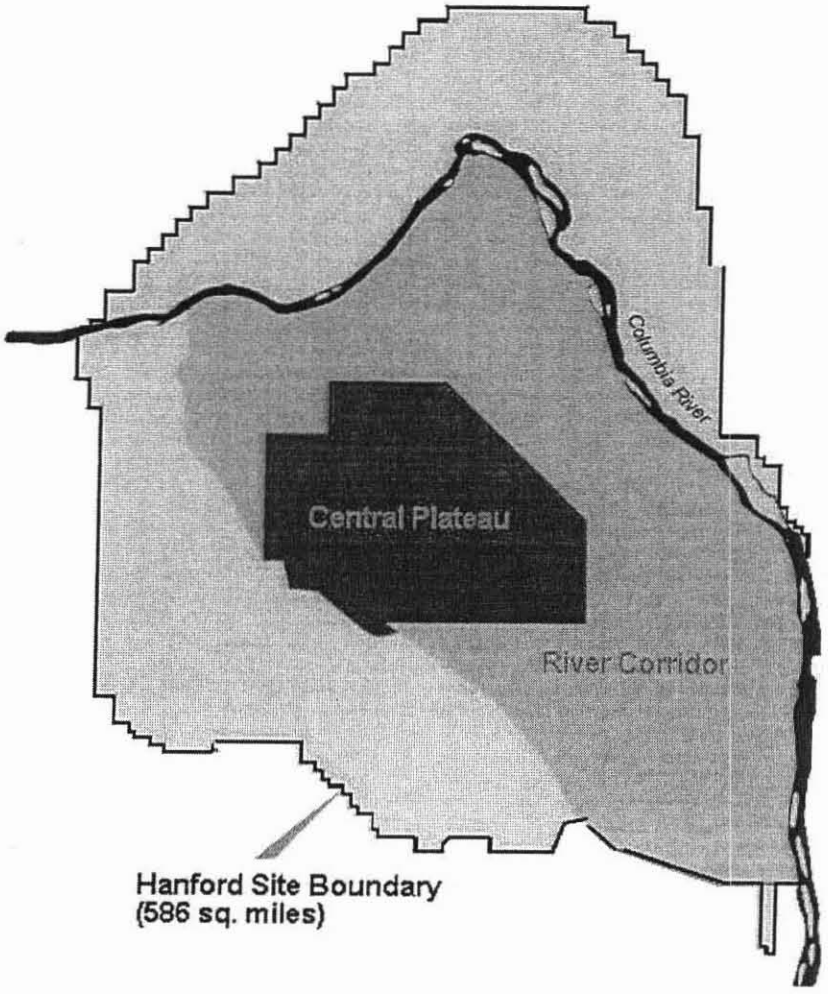
Office of River Protection

- More than 50 million gallons of tank waste in 177 underground storage tanks

DOE has two offices at the Hanford Site overseeing cleanup activities. The Office of River Protection (ORP), established by the U.S. Congress in 1998, manages waste retrieval from, and closure of, 177 underground waste tanks. The ORP also manages the construction of a Waste Treatment and Immobilization Plant that will turn radioactive and chemical wastes into a stable glass form (vitrification). The Richland Operations Office (RL) is responsible for cleaning up the balance of the contamination that is the legacy from the Hanford Site national defense missions. Overall, Hanford cleanup efforts involve more than 11,000 employees and an annual budget of about $2 billion.

RL is focused on two primary goals: (1) restoring the lands in the Columbia River Corridor to a condition where they are suitable for conservation and recreational uses and (2) transitioning the central portion of the Hanford Site – called the Central Plateau because land rises to approximately 300 feet (91 meters) above the river – to a modern, protective, waste management operation (Figure 2).

Figure 2 – Areas of Cleanup Focus



Central Plateau
(75 square miles [194 square kilometers])
- Demolish approximately 1000 structures/facilities
- Remediate and close approximately 850 waste sites and burial grounds
- Remediate and clean up 5 large processing canyons
- Remediate and treat groundwater plumes

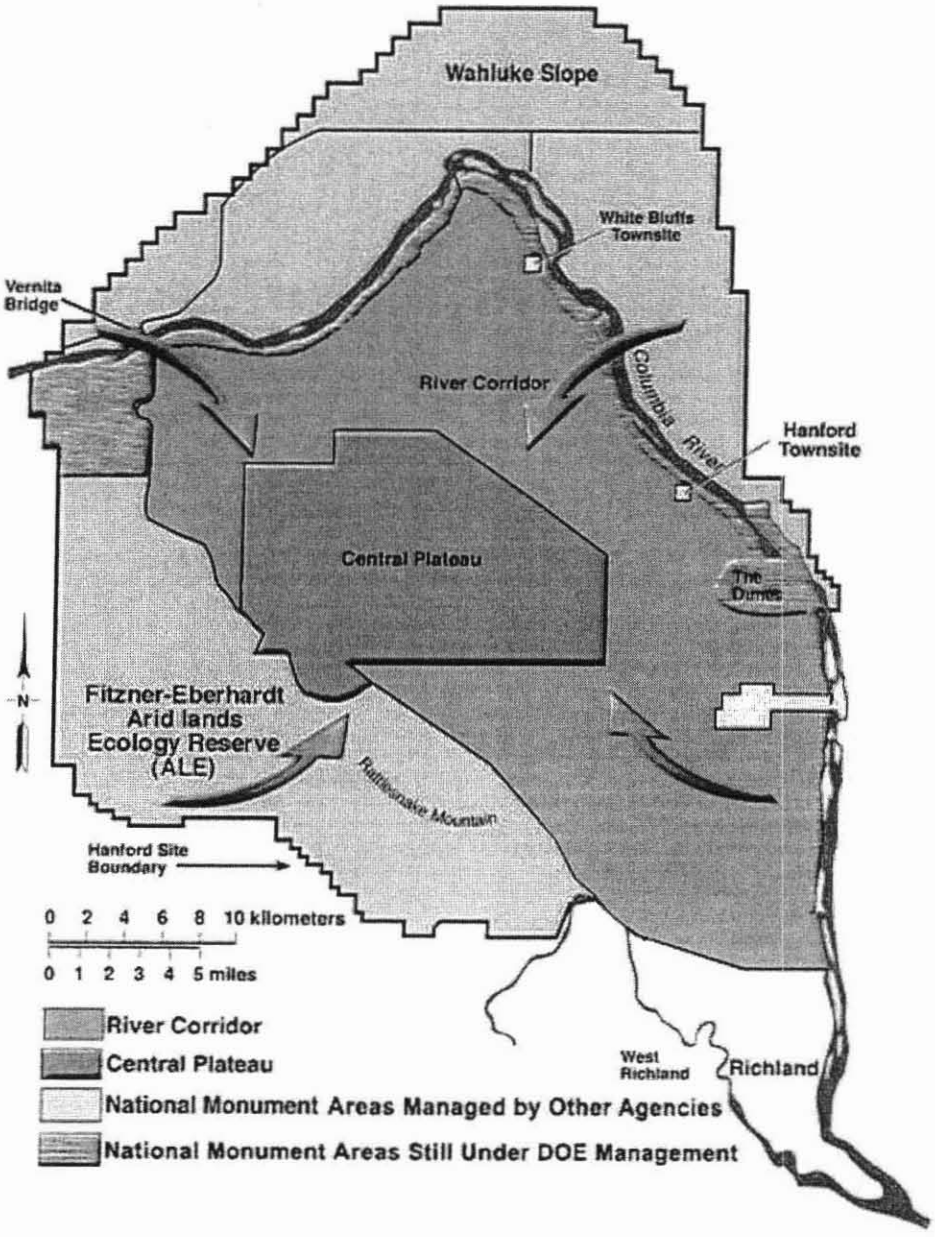
River Corridor
(218 square miles [565 square kilometers])
- Demolish approximately 500 structures/facilities
- Remediate and close approximately 750 waste sites
- Place 9 reactors into interim safe storage configuration
- Remediate and treat groundwater plumes

The River Corridor stretches out over 210 square miles (544 square kilometers) along a little over 50 miles (80 kilometers) of the Columbia River shoreline. Nine former plutonium production reactors, fuel fabrication sites, research and support facilities, and hundreds of waste sites are located in the River Corridor area. The nine production reactors are being put into interim safety storage condition to be remediated in the future. With few exceptions, the rest of the buildings, structures, and facilities in the River Corridor are being remediated, including all waste sites. The wastes from all the remediation activities are being disposed in the Environmental Restoration Disposal Facility (ERDF).

The Central Plateau covers approximately 75 square miles (194 square kilometers) formerly dedicated to plutonium recovery operations and managing wastes. The Central Plateau is being transitioned for long-term use to manage, treat, store, and dispose of wastes generated on the plateau and in other areas of the Hanford Site. The Central Plateau contains approximately 1,000 buildings and structures, including 5 large chemical processing facilities, and 850 waste sites, including the Central Waste Complex, ERDF, and other facilities that are currently being used for waste management and disposal.

In addition to cleanup, a key DOE objective is to shrink the area of the Hanford Site for which DOE is responsible (Figure 3). The ultimate DOE goal is to release the balance of the land for other uses and possibly for management by another government agency such as the U.S. Fish and Wildlife Service. DOE would only retain responsibility for the waste management activities on the Central Plateau.

Figure 3 – Shrinking the Site



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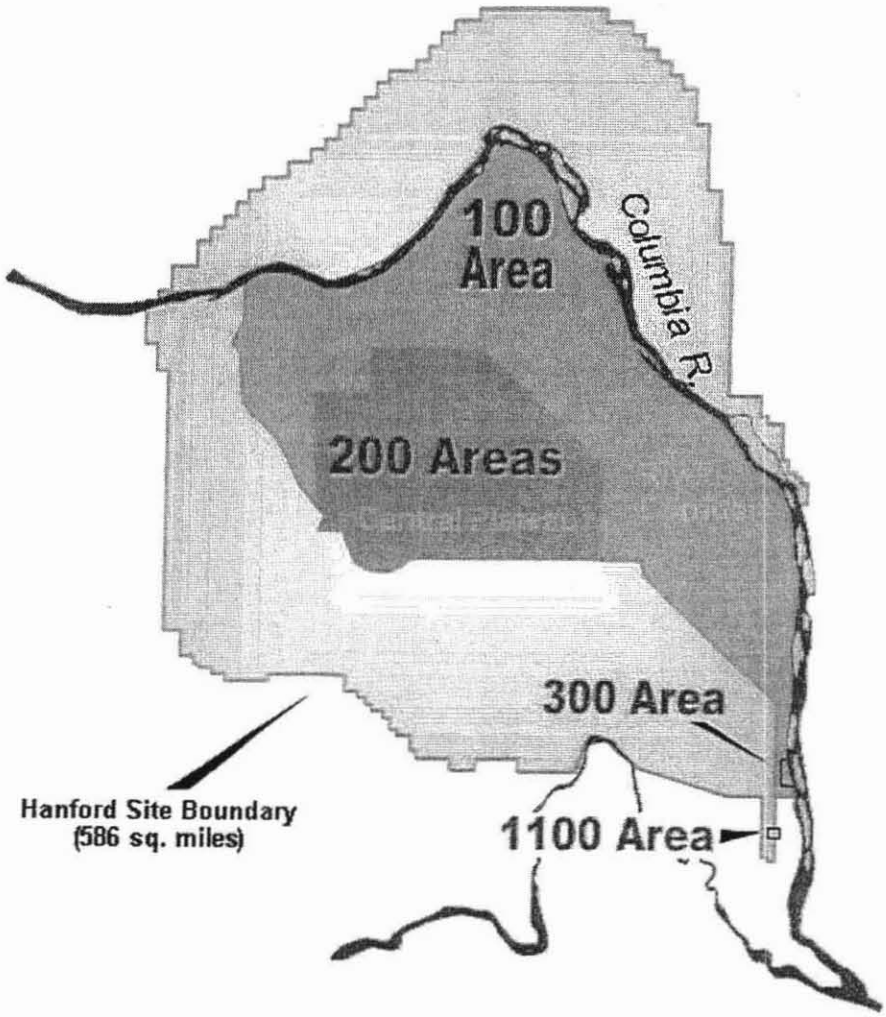
2.0 REGULATORY ENVIRONMENT

The Hanford Site was placed on the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) National Priorities List (NPL) in 1989. Four sub-areas of the Hanford Site (100 Areas, 200 Areas, 300 Area, and 1100 Area [Figure 4]) were officially listed on the NPL on November 3, 1989. The 100 Areas NPL Site and the 300 Area NPL Site are included in the River Corridor Project. The 200 Areas are in the Central Plateau Project. Remediation of the 1100 Area NPL Site has been completed, and the 1100 Area has been deleted from the NPL.

Figure 4 – National Priority Cleanup Areas



In addition, *Resource Conservation and Recovery Act of 1976* (RCRA) provisions governing compliance, permitting, closure, and post-closure care of treatment, storage, or disposal (TSD) units apply to active TSD units. The 100 Areas, 200 Areas, and 300 Area are considered active TSD units.

DOE is conducting Hanford Site cleanup in accordance with regulatory requirements under CERCLA, RCRA, the *Atomic Energy Act of 1954* (AEA), Executive Order 12580 (Superfund Implementation), and the *Revised Code of Washington* "Hazardous Waste Management." The Tri-Party Agreement, signed by DOE, EPA, and Ecology on May 15, 1989, is the legally enforceable agreement for complying with CERCLA remedial action provisions and with RCRA. The Tri-Party Agreement defines how the three agencies work together to accomplish Hanford Site cleanup, as well as how the agencies interact to meet their individual and collective responsibilities.

DOE is the "Lead Agency" under CERCLA and has ultimate responsibility for completing the remediation of the Hanford Site in compliance with the applicable or relevant and appropriate environmental regulatory requirements. Under CERCLA, EPA is a support agency to DOE to facilitate successful completion of Hanford Site cleanup. The Governor of Washington State selected Ecology as the lead state agency to assist DOE in completing cleanup. Both EPA and Ecology have regulatory oversight responsibilities to ensure that DOE's actions meet environmental regulatory requirements.

There are however many other organizations that have a role in the Hanford Site cleanup process. Table 2 shows these agencies and their roles.

Table 2 - Hanford Cleanup Roles

DOE
- Federal Lead Agency
- Ultimate responsibility for all CERCLA actions
- Responsible to select and execute remedial actions
- Responsible for funding all cleanup actions
- Must reimburse Washington State for all costs to oversee cleanup
- Natural resource trustee

EPA
- Supports DOE in selecting remedial actions
- Must approve selected remedial actions
- Must approve sampling and analysis plans
- Upon request from DOE, delete sites from NPL
- Lead regulatory agency for oversight of CERCLA actions

Department of Interior (US Fish and Wildlife Service)
- Responsible for management of the Hanford Reach National Monument
- Natural resource trustee

National Oceanic and Atmospheric Administration
- Natural resource trustee (primarily Columbia River)

Washington Department of Ecology
- Regulates RCRA hazardous waste TSD units
- Supports EPA in carrying out its CERCLA responsibilities
- Lead regulatory agency for some remedial actions
- Natural resource trustee

Table 2 - Hanford Cleanup Roles

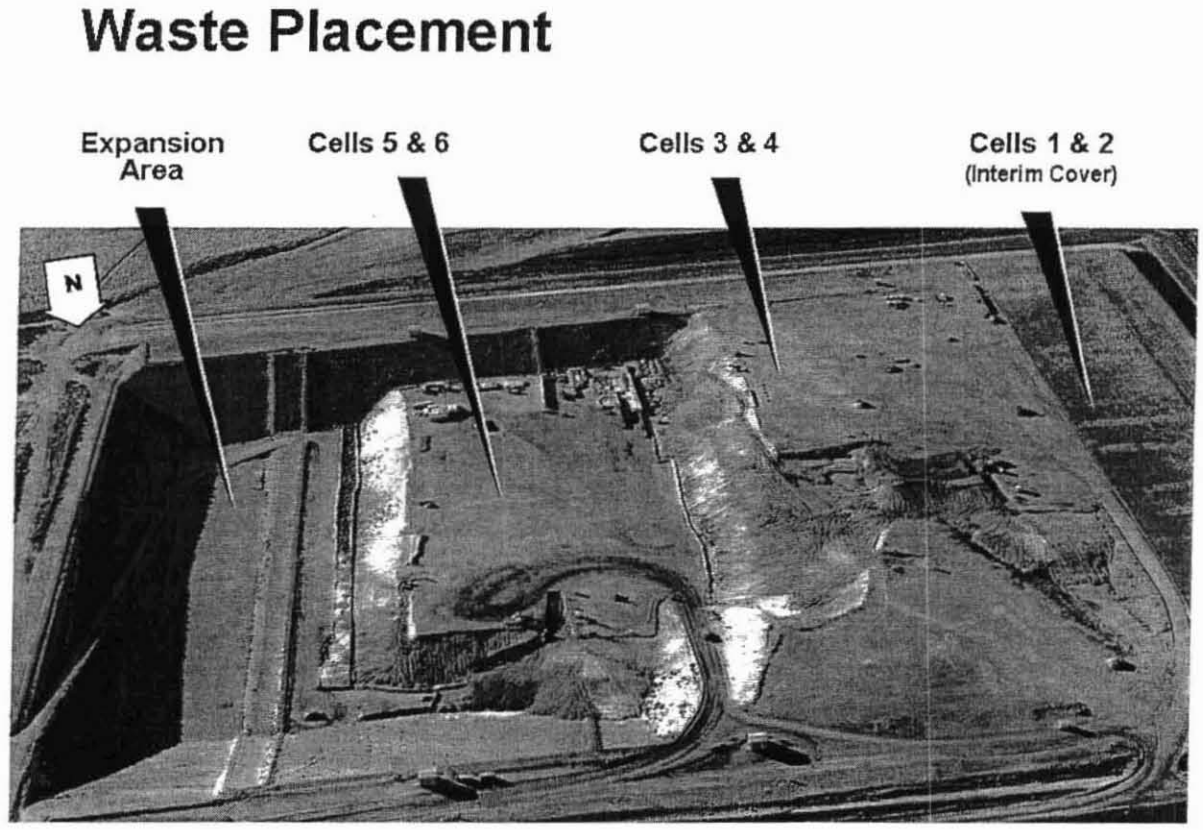
Oregon State - Natural resource trustee Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, Yakama Nation - Each separately has sovereign nation status - Each is a Natural resource trustee

3.0 ROLE OF THE ENVIRONMENTAL RESTORATION DISPOSAL FACILITY

The cleanup of Hanford's River Corridor would not be possible without ERDF. The landfill, located in the middle of the Hanford Site Central Plateau, was opened in 1996. Without ERDF, wastes would have to be shipped to an offsite disposal facility at a much higher cost. ERDF disposal costs are about $30 per ton, including transportation.

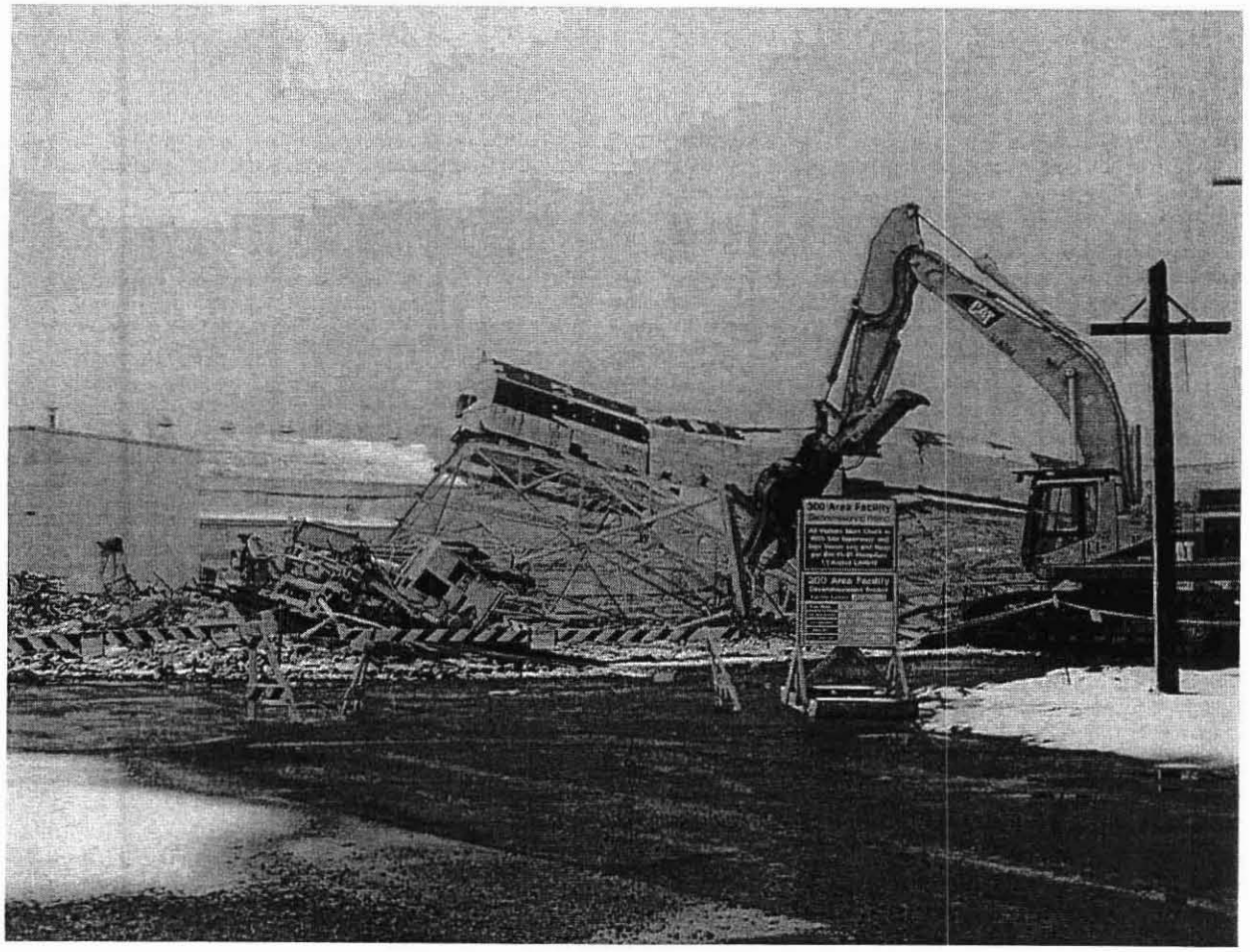
Designed to be expanded, ERDF currently consists of six disposal cells. Additional cells are constructed two cells at a time, as needed (Figure 5).

Figure 5 – ERDF Design



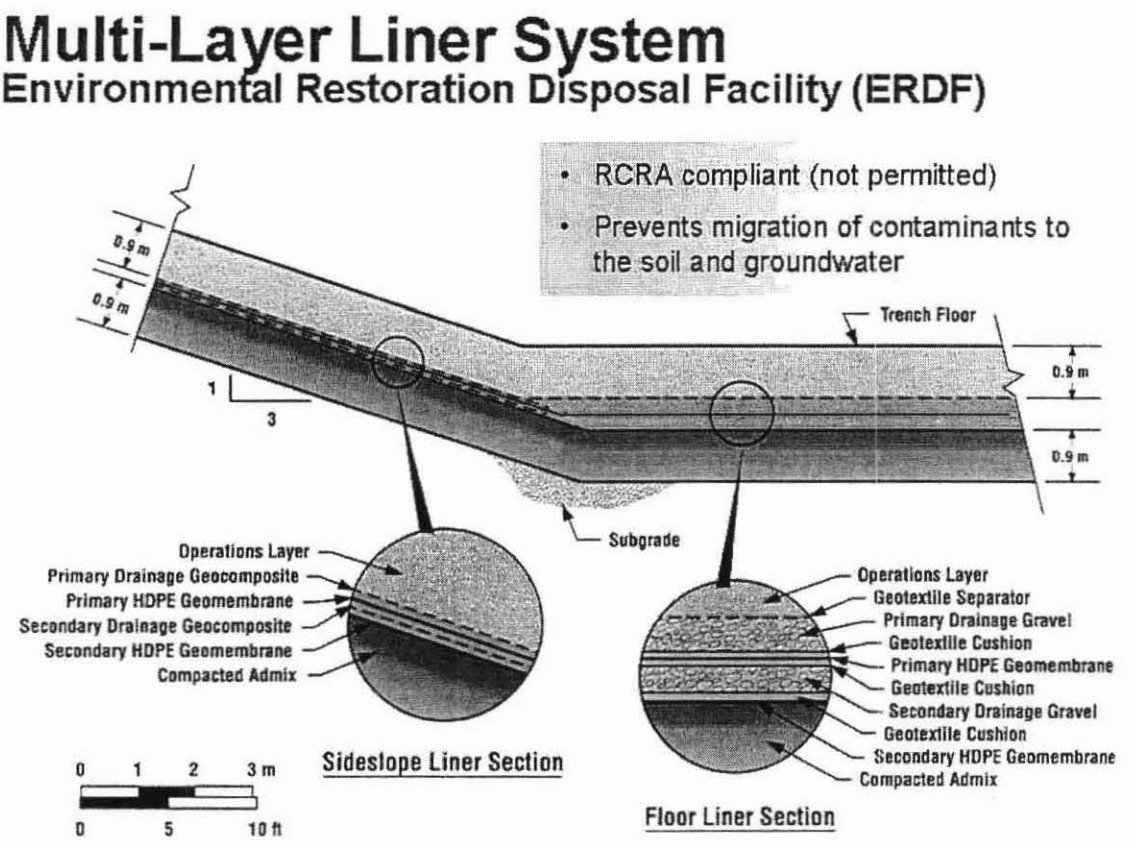
The surface area on the ERDF floor is 1.5 million square feet (140K square meters). As of June 2007, ERDF contained almost 7 million tons of contaminated material from the River Corridor. This includes material from waste sites and burial grounds, as well as demolition debris from hundreds of facilities (Figure 6).

Figure 6 – Typical Debris Going to ERDF



The ERDF has both a primary and secondary liner system that contains and collects rainwater or water used for dust suppression (Figure 7). The water that makes its way through the waste and collected by the liner system is called leachate, and contains hazardous and radioactive materials that leach out of the waste, although to date concentrations have been low. The leachate is collected and sent to the onsite Effluent Treatment Facility for evaporation. The resulting solids are returned to ERDF for disposal.

Figure 7 – ERDF Protective Design Liner System



Located under the primary and secondary liner system is a one-meter thick layer of dense clay and native soils that are mixed and compacted to protect the underlying groundwater from a failure in the liner system. The distance between the clay-soil mixture and the groundwater – about 250 feet (75 meters) – is an additional, natural barrier.

Several years ago, an interim cover was placed on that portion of ERDF that had been filled to capacity. The cover will be expanded as other sections of ERDF are filled. Once the entire facility is full and ready to be closed, a final, permanent cover will be installed.

CERCLA cleanup activities on the Hanford Site began in earnest in 1992. Until ERDF operations began in 1996, wastes from CERCLA removal and remedial actions were stored at the sites where they were generated. Since ERDF became operational, all CERCLA wastes have been disposed in ERDF, either directly or after completing any required treatment to meet ERDF acceptance criteria.

The regulatory requirements specific to ERDF were first defined in the ERDF Record of Decision (ROD) issued in January 1995, which has been supplemented or amended seven times since. The regulations describe the requirements for construction of a landfill but they do not prescribe the operational requirements. For RCRA landfills, the operational requirements are

delineated in a RCRA permit. However, permits are not required for CERCLA landfills so the operational requirements for ERDF are described in a remedial action work plan (RAWP). The requirements in the RAWP became enforceable upon approval of the work plan by the lead regulatory agency; for ERDF that is the EPA.

One of the operational requirements for ERDF defined in the RAWP calls for compaction testing using a prescribed method. Implementing that method successfully at ERDF was difficult due to the types of waste being disposed. The requirements also specify that the leachate collection system must be operated in a manner that ensures the liquid level in the system never exceed one foot (30 centimeters) in depth. A separate requirement in the RAWP called for the leachate collection system to be inspected weekly to ensure it was operating properly.

4.0 RECENT EXAMPLE OF REGULATOR ACTION

On March 27, 2007, EPA issued a letter notifying RL it was prepared to assess penalties totaling $1,140,000 for CERCLA violations at ERDF. As shown in Table 3, this was an exceptional penalty compared to past assessments. The EPA letter stated that DOE may dispute the basis for the imposition of the stipulated penalties, but not the proposed amount.

Table 3 – Recent Hanford Site Environmental Fines and Penalties

Amount Levied ($)	Date Issued	Agency	Penalty Basis	Disposition
1,140,000	03/27/07	EPA	CERCLA. Leachate collection system problems; noncompliance with ERDF Operations Plan (compaction)	TBD
120,000	10/16/06	EPA	Noncompliance with CERCLA	Paid
75,000	04/28/05	EPA	Failure to complete Tri-Party Agreement milestone	Paid
270,000	09/21/04	Ecology	RCRA. Shipment noncompliance	Paid
76,000	04/03/03	EPA	Failure to complete Tri-Party Agreement milestone	Paid
57,800	03/26/01	Ecology	RCRA. Improper storage of chemical (collodian)	Closed by settlement agreement

The fine was based on an event (assumed to be a lightning strike) that occurred in May 2006 that affected the pumps that are designed to operate automatically when the level of leachate exceeds prescribed settings. Contractor management did not discover the inoperable leachate pumps in two of the six disposal cells until December 2006, although technicians had recorded the lack of flow from the pumps. Additionally, a management assessment triggered by this event revealed that required compaction tests were not completed for a period of 6 weeks (2 weeks in October and 4 weeks in November 2006).

Additional contractor assessments conducted in response to these findings revealed some compaction test data did not correspond to records of entry into the contaminated area where

compaction tests are performed. When the technician responsible for taking these tests was confronted with this discrepancy, he admitted to not performing the compaction tests and indicated he had fabricated the data.

The Tri-Party Agreement maximum stipulated penalties are $5,000 for the first week of violation and $10,000 every week thereafter. The EPA calculated its penalty on the basis of: (1) failure to perform weekly inspections that would have detected the presence of leachate and the improper functioning of the leachate system ($305,000 for 31 weeks of violation), and (2) failure to perform compaction tests ($835,000 for 84 weeks of violation). EPA calculated the penalty to the maximum amount based on their belief these were serious and significant violations. (Proper compaction is essential to ensure subsequent waste settlement does not damage the eventual ERDF cap.) While the contractor is corporately responsible for the fine (no government funds are used to pay), RL remains responsible for legal agreements and for satisfying the EPA.

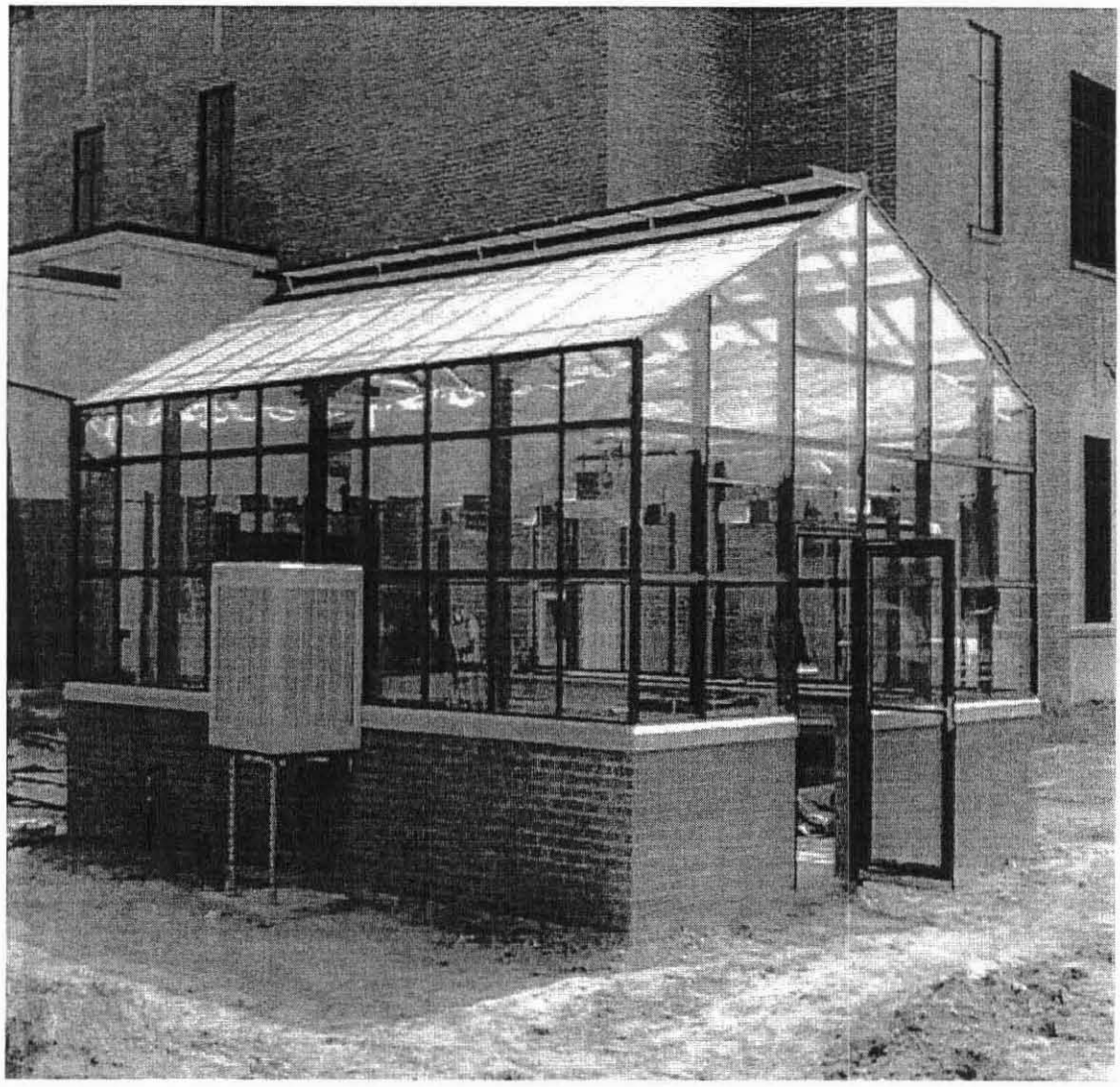
DOE and the contractor have taken extensive corrective action including strengthening disciplined conduct of operations, upgrading work documents, purchasing new compaction equipment, conducting formal lessons learned and increasing oversight. ERDF has largely returned to its former operational status.

5.0 MITIGATING THE FINE

Unlike other recent penalties, in this case RL and the contractor, with support from EPA, have proposed implementing supplemental environmental projects (SEP) rather than making a payment to the U.S. Treasury. This option, which can only be used to mitigate a portion of the fine (typically 75%), addresses environmental opportunities and needs in the local area.

DOE and the contractor have proposed two SEPs. The first provides funding to a local university for construction of a greenhouse and nursery facility to be used to produce native plants and seeds that may be beneficial for vegetation of closed/capped waste sites and landfills at the Hanford Site, and for potential revegetation of other areas. The availability of native plant and seed sources for revegetation is currently very limited, both in quantity and number of species. For example, after recent fires, non-native seed was used to restore part of those lands because native seed was not available. Invasive, non-native species are a concern, especially to the Tribal Nations. The expected benefit of this SEP includes creation of a seed bank and improved ability for the local university to teach ecological restoration skills. Figure 8 shows an existing (smaller) university greenhouse currently used to grow native vegetation after which the new greenhouse will be modeled.

Figure 8 – Existing University Greenhouse



The second SEP recognizes two-thirds of Benton County is bordered by the Columbia River. The total perimeter length of the Columbia River around Benton County is approximately 182 miles (292 kilometers). This SEP provides assistance to emergency planning and response organizations to help respond better to oil spills and hazardous substance releases to local rivers by providing two boats to local law enforcement. The SEP includes an agreement to form a response team of personnel from local agencies to respond to emergency incidents, including oil and hazardous substance releases, on the Columbia, Yakima, Walla Walla, and Snake Rivers. Figure 9 shows one of the two boats to be provided.

Figure 9 – Emergency Response Boat

6.0 CONCLUSIONS

Although both the Hanford cleanup and its related regulatory process are complex, cooperation among the TPA agencies and other entities with Hanford interests has supported significant cleanup progress. ERDF continues to play a key role in this progress. Recent issues with disciplined conduct of operations resulted in an unprecedented fine and EPA as the lead regulator withdrawing support for operations. Through broad and proactive response actions ERDF was able to resume waste placement. In addition, DOE, the contractor, and EPA are working to ensure much of the fine is used to support local environmental improvements.

7.0 REFERENCES

Letter, to Manager, Richland Operations Office form Director, Office of Environmental Cleanup EPA, "Stipulated Penalties for Violations of CERCLA Requirements at the Environmental Restoration Disposal Facility," dated. March 27, 2007, U.S. Environmental Protection Agency, Washington, D.C.

"Hazardous Waste Management," *Revised Code of Washington*, Chapter 70.105, as amended.

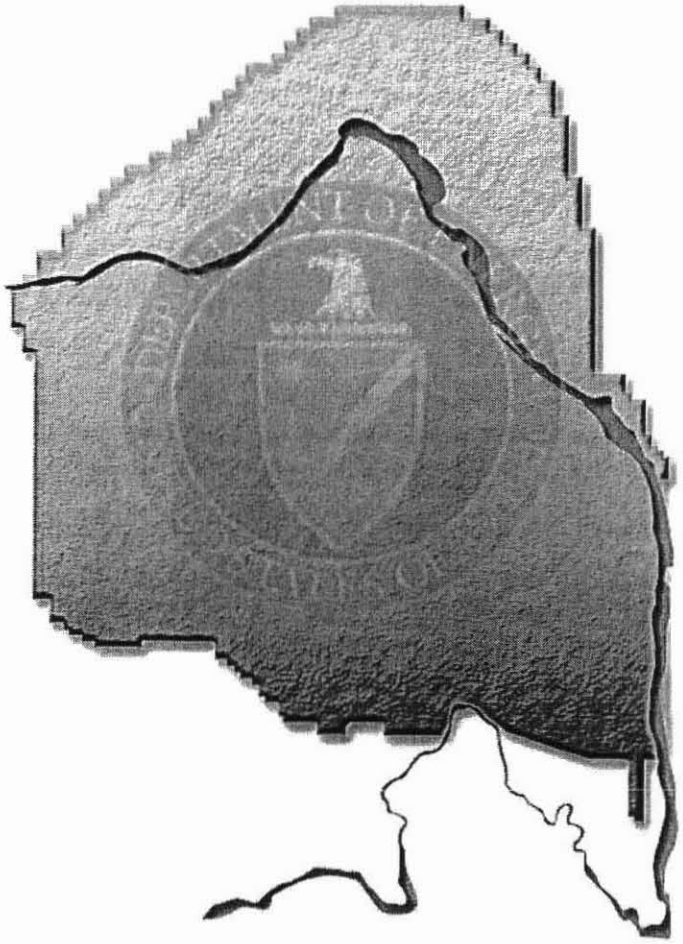
Atomic Energy Act of 1954, Public Law 83-703, 68 Stat. 919, 42 USC 2011.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq. as amended.

Executive Order 12580, "Superfund Implementation," *Federal Register*, 52 FR 2923, January 29, 1987.

Hanford Federal Facility Agreement and Consent Order, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, as amended.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq., as amended.



Regulation at Hanford

U.S. Department of Energy

Richland Operations Office

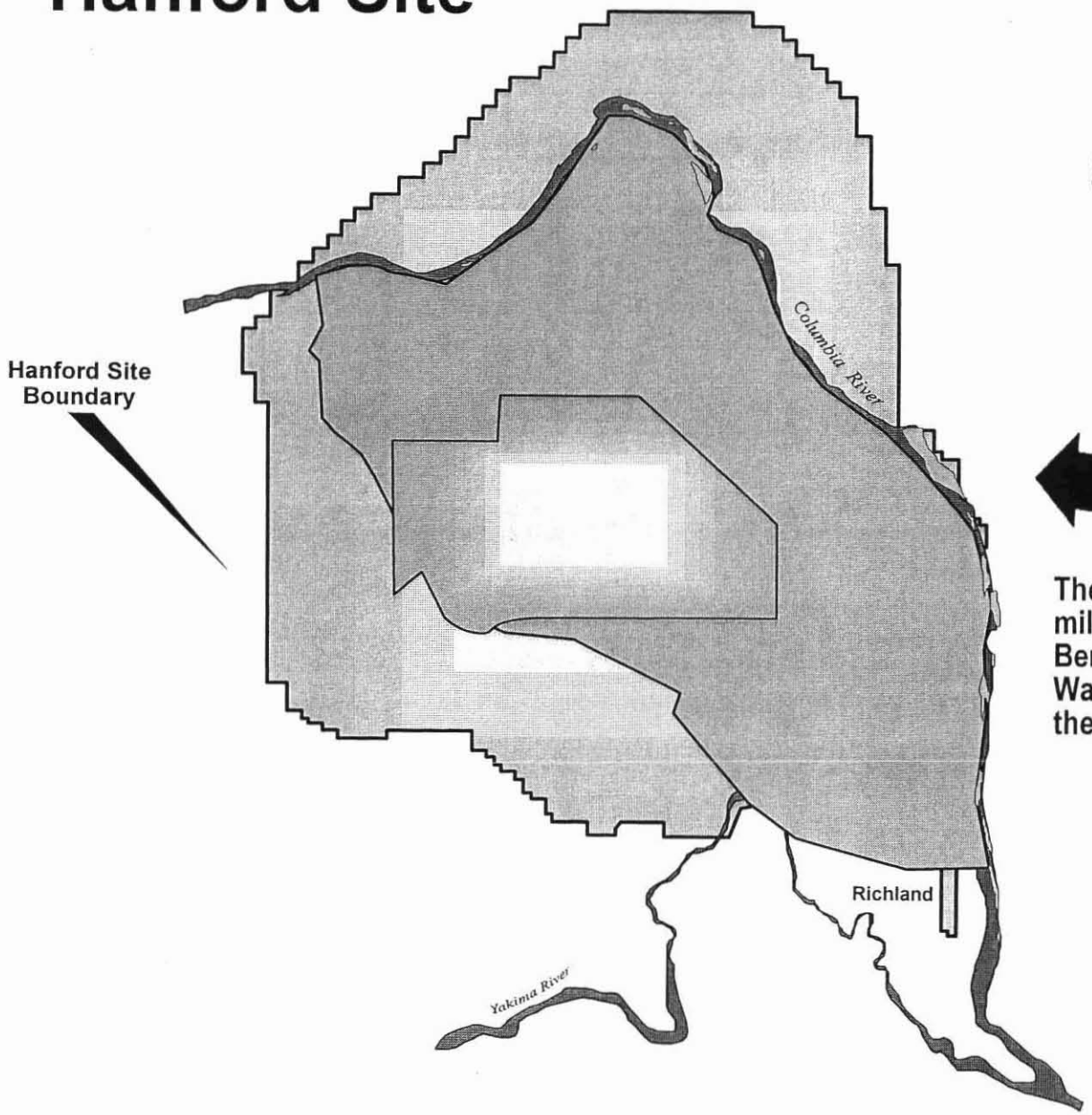
Al Hawkins
Senior Technical Advisor

September 27, 2007

EM Environmental Management

safety ❖ performance ❖ cleanup ❖ closure

Hanford Site



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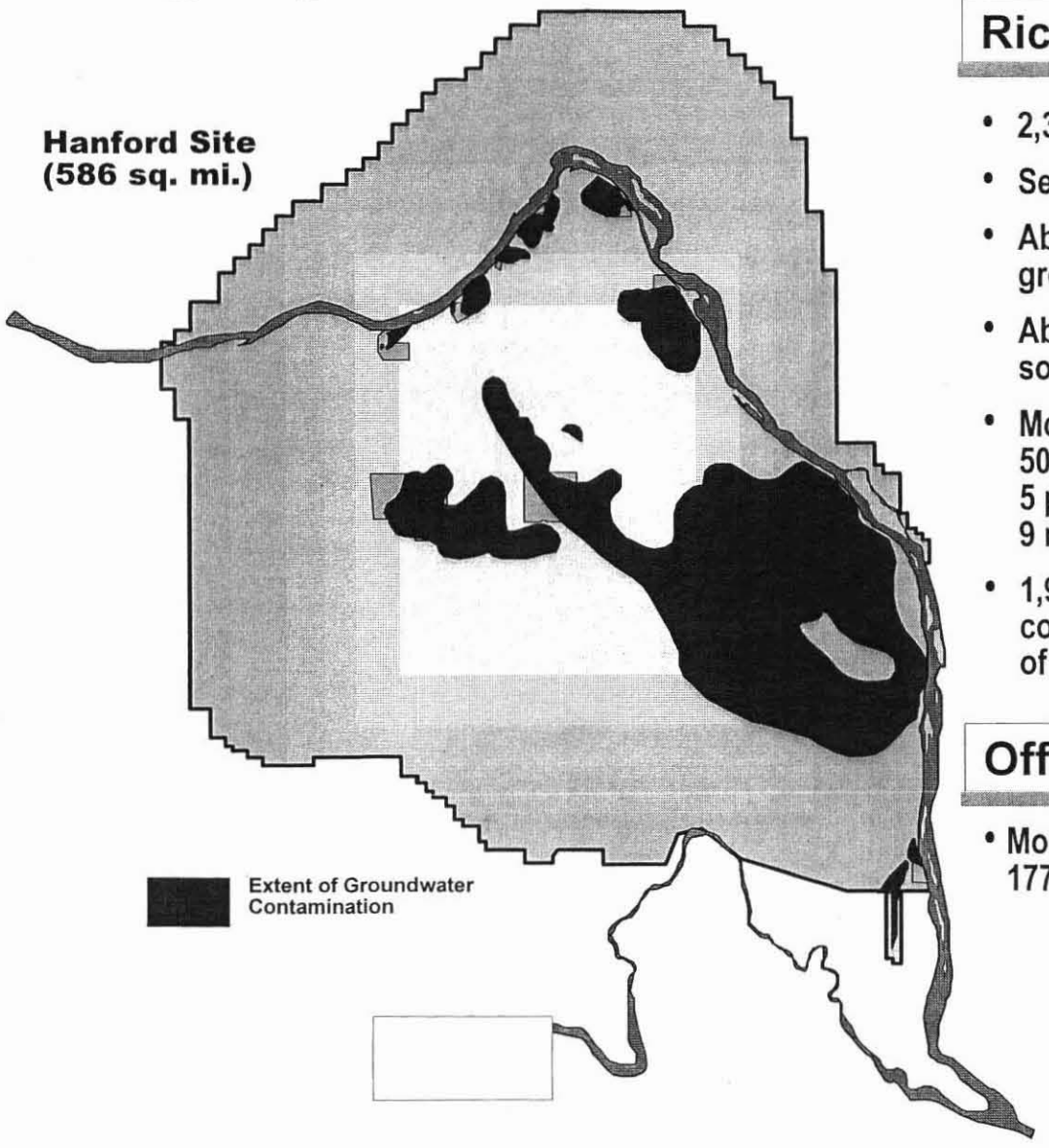
Legacy



Richland Operations Office

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- More than 1,600 waste sites and 500 contaminated facilities, including 5 processing "canyon" facilities and 9 reactor complexes
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Office of River Protection

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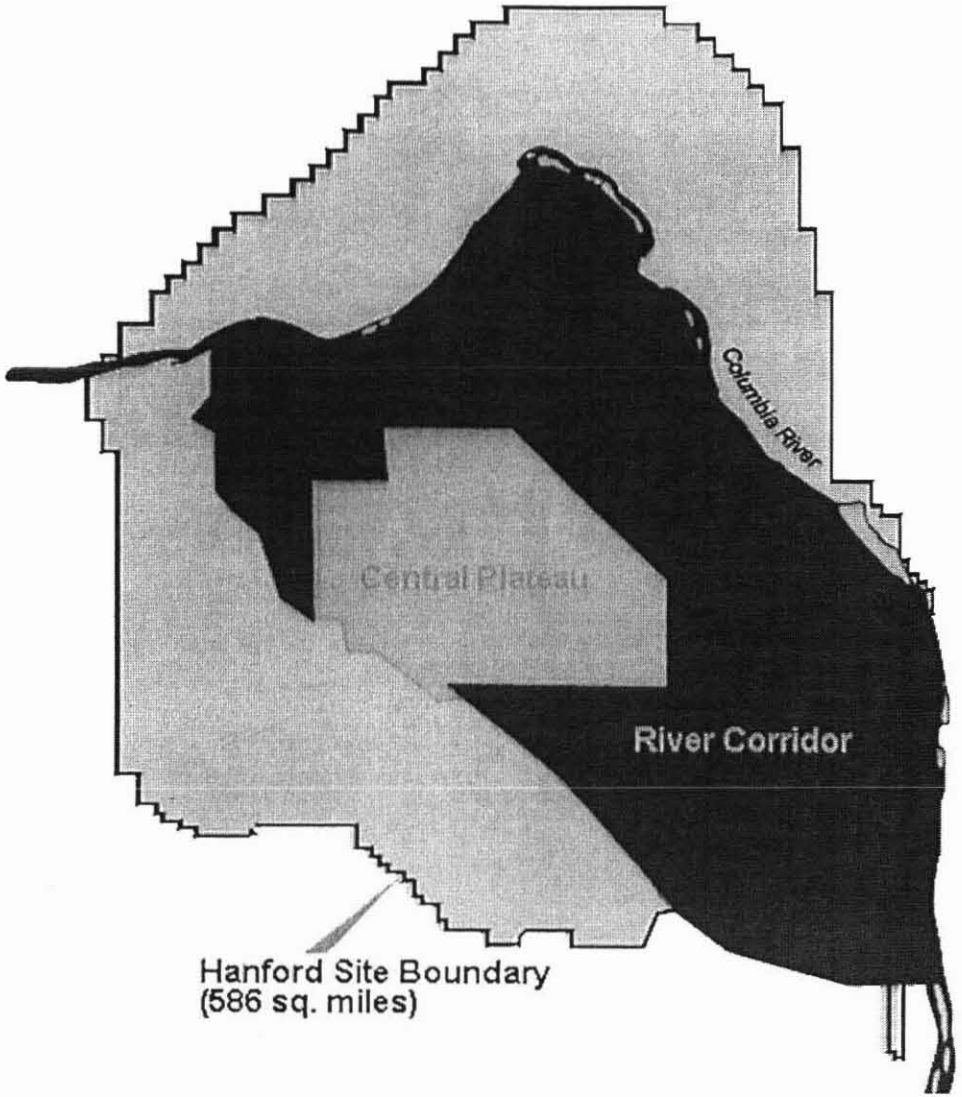
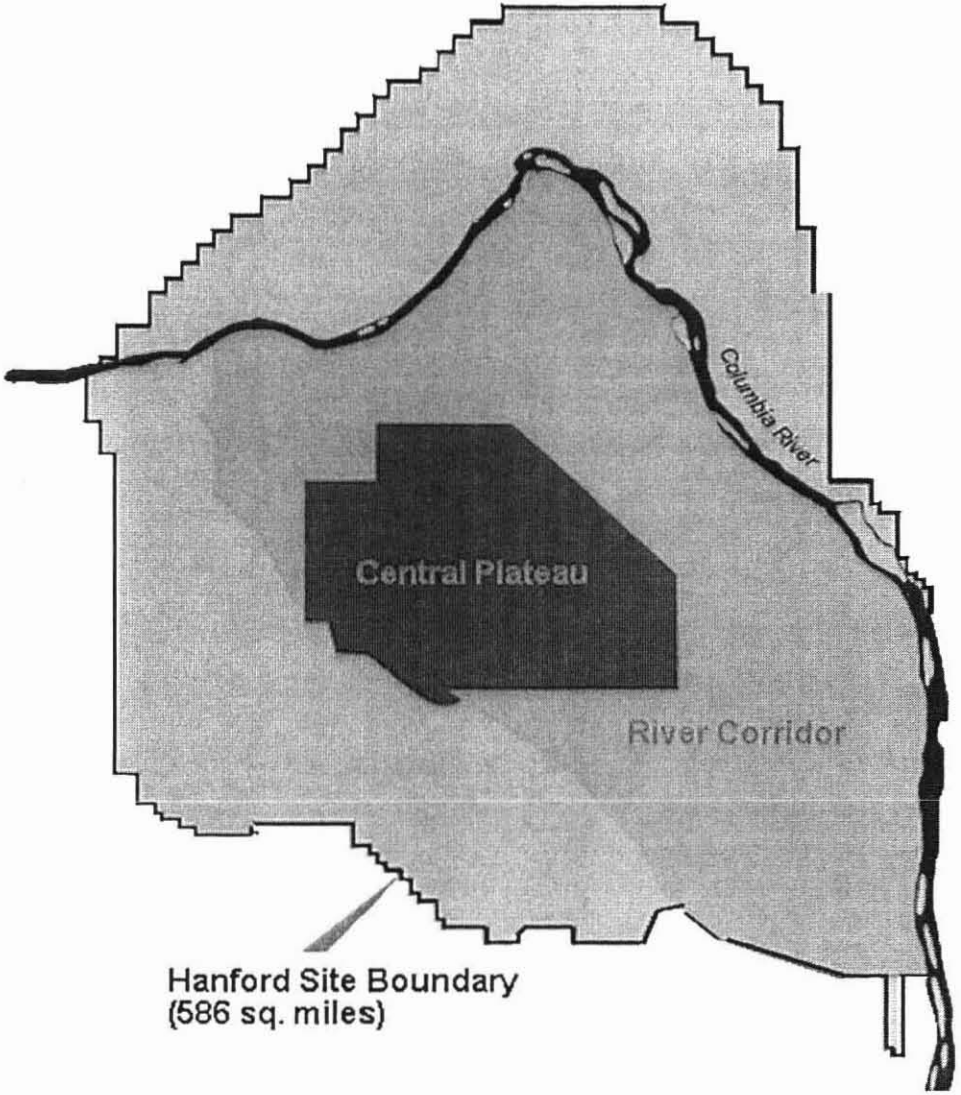
River Corridor Cleanup Goals



River Corridor
(218 square miles)

- **Demolish 500 structures/facilities**
- **Remediate and close 750 waste sites**
- **Place 9 reactors into interim safe storage configuration**
- **Remediate and treat groundwater plumes**

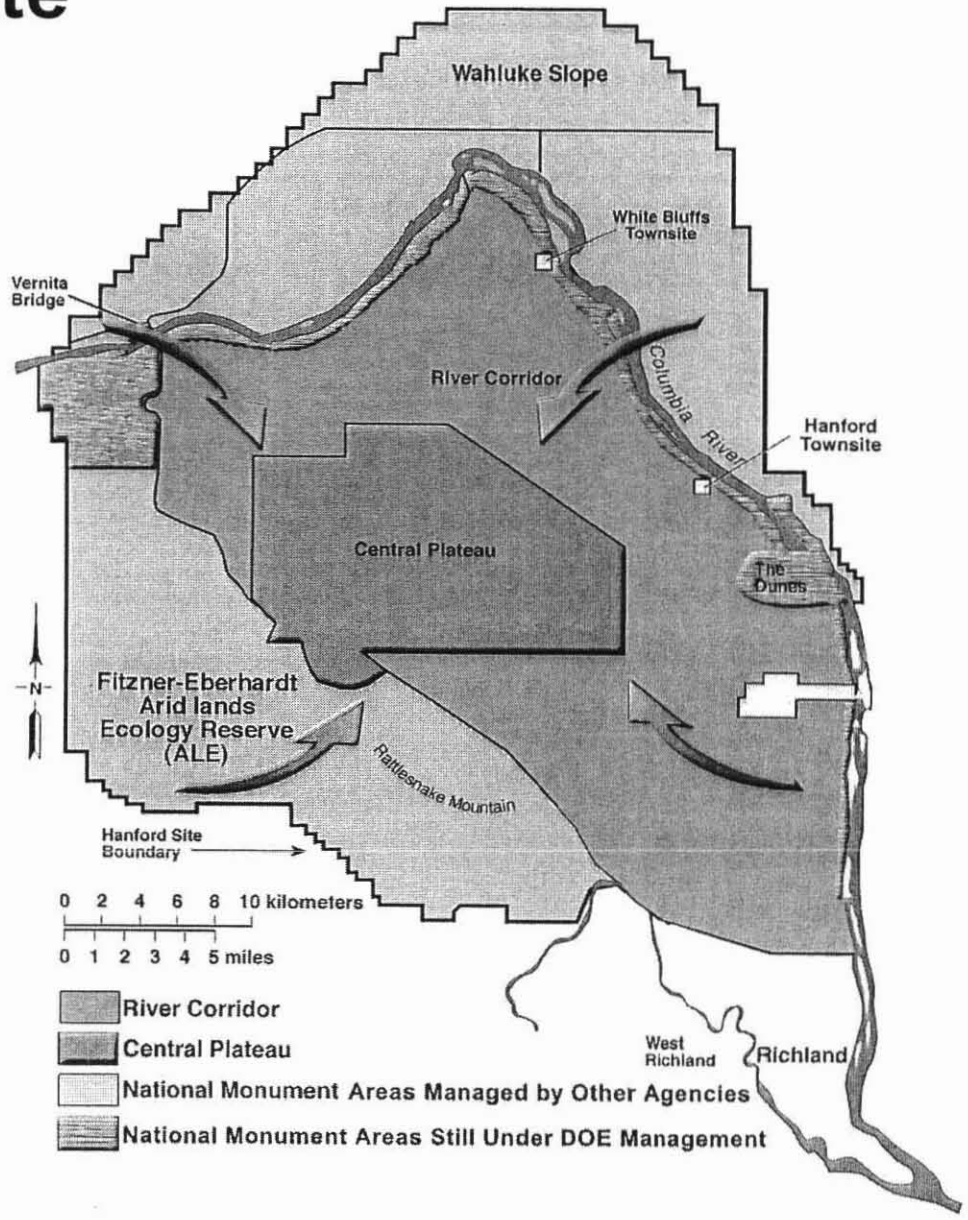
Central Plateau Cleanup Goals



Central Plateau
(75 square miles)

- **Demolition of 1000 structures/facilities**
- **Remediation and closure of 850 waste sites and burial grounds**
- **Remediate and clean up five large processing canyons**
- **Remediate and treat groundwater plumes**

Shrinking the Site



Rich in Natural Resources

- <10% of land used for production – remainder uniquely well preserved and ecologically significant
- Hanford Reach National Monument
  - Shrub-steppe habitat
  - Rich cultural history
  - Last free-flowing stretch of Columbia River
- Home to many threatened and endangered species

Regulatory Environment

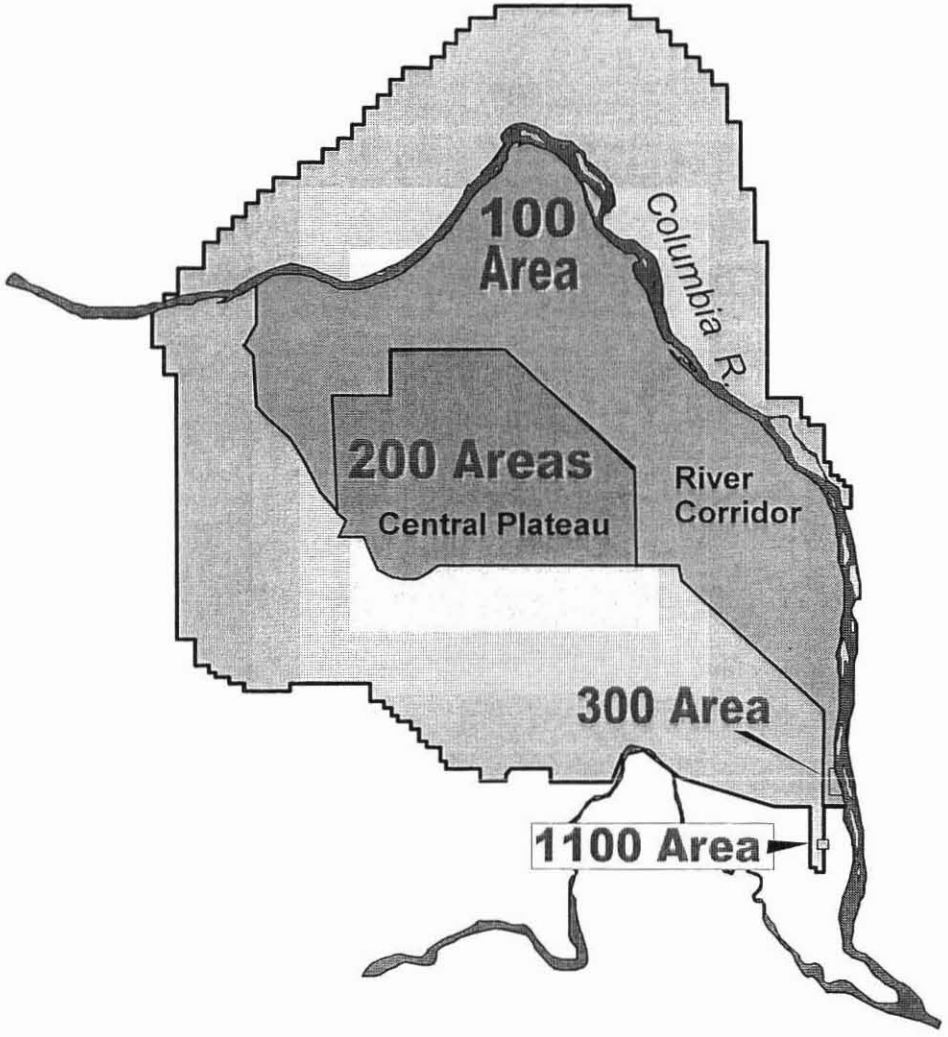
- **Hanford Placed on NPL in 1989**
  - **Four sub-areas: 100, 200, 300, 1100***
    - **100 and 300 in River Corridor**
    - **200 in Central Plateau**
- **Tri-Party Agreement (1989)**
  - **DOE is "lead agency"**
  - **EPA and State (Ecology) have regulatory oversight**
  - **Defines how agencies interact**

*Remediation of the 1100 Area NPL Site has been completed; the 1100 Area has been deleted from the NPL

Regulatory Environment (cont'd)

- **Others With Active Roles:**
  - Department of Interior (Fish and Wildlife)
  - National Oceanic and Atmospheric Admin (river)
  - Oregon State (down river)
  - Nez Perce Tribe
  - Confederated Tribes of the Umatilla
  - Yakama Nation
  - Other Washington State Agencies (Health, State Fish and Wildlife)

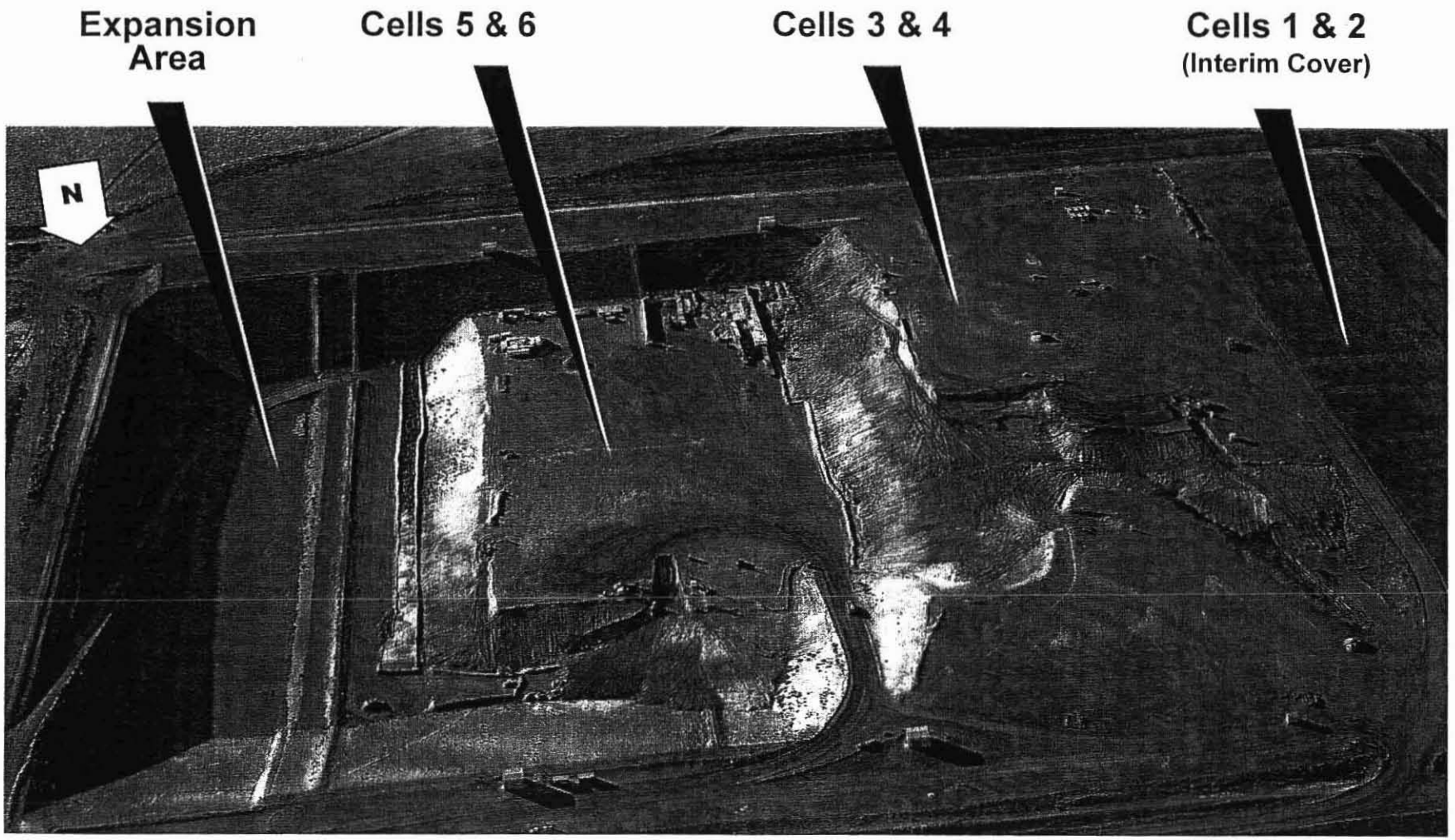
Regulatory Environment (cont'd)



EPA Listed Areas (NPL)

- 100 and 300 Areas in River Corridor
- 200 Area in Central Plateau
- 1100 Area was deleted from NPL after remediation was complete

Waste Placement at Environmental Restoration Disposal Facility



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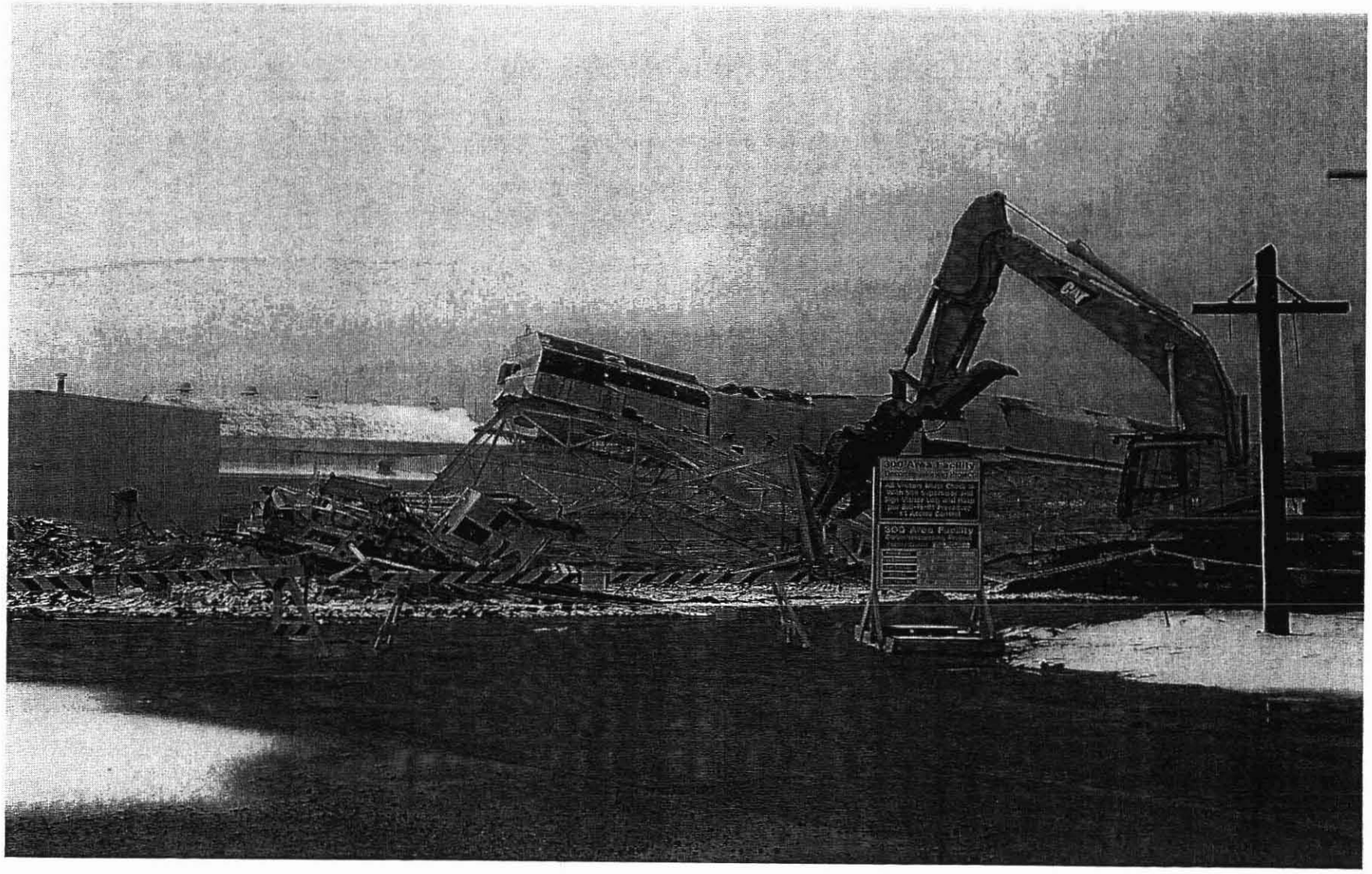

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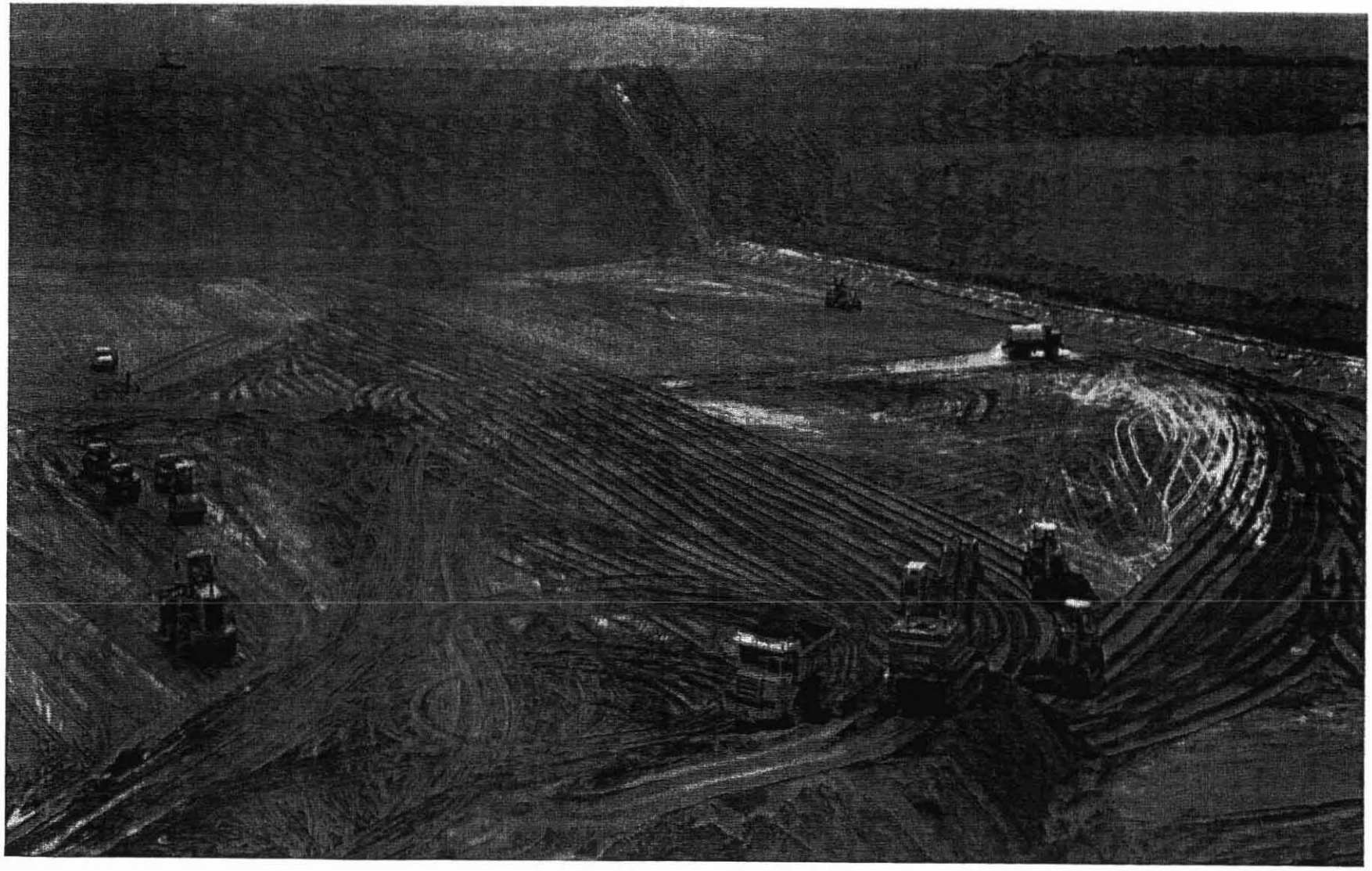
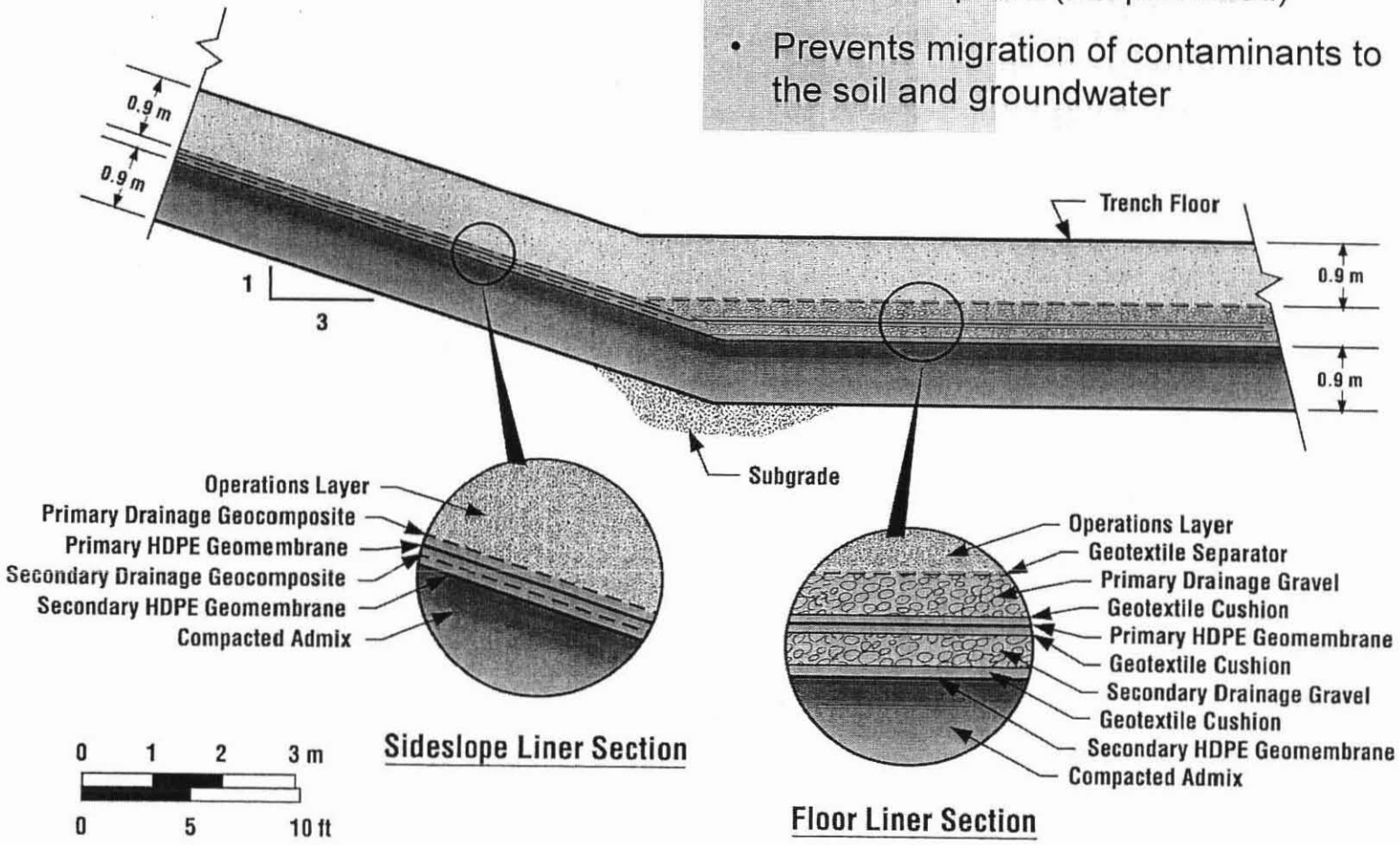


Multi-Layer Liner System
Environmental Restoration Disposal Facility (ERDF)

- RCRA compliant (not permitted)
- Prevents migration of contaminants to the soil and groundwater



ERDF Regulatory Requirements

- Defined in Record of Decision (1995)
- EPA is Lead Regulatory Agency
- Operational Requirements in Remedial Action Work Plan
  - Requires adequate compaction
  - Requires leachate collection, weekly inspection to ensure proper operation

Recent Environmental Fines

Amount Levied ($K)	Date Issued	Agency	Penalty Basis	Disposition
$1,140	3/07	EPA	CERCLA	TBD
120	10/06	EPA	CERCLA	Paid
75	4/05	EPA	TPA milestone	Paid
270	9/04	Ecology	RCRA	Paid
76	4/03	EPA	TPA milestone	Paid
58	3/01	Ecology	RCRA	Settlement agreement

The "Event"

- Inoperable leachate pumps in two cells
  - Probably result of lightening strike
  - Operators recorded lack of flow
- Compaction test data
  - Difficult to perform due to ERDF content
  - Data recorded but no record of site entry
  - Technician admitted falsification

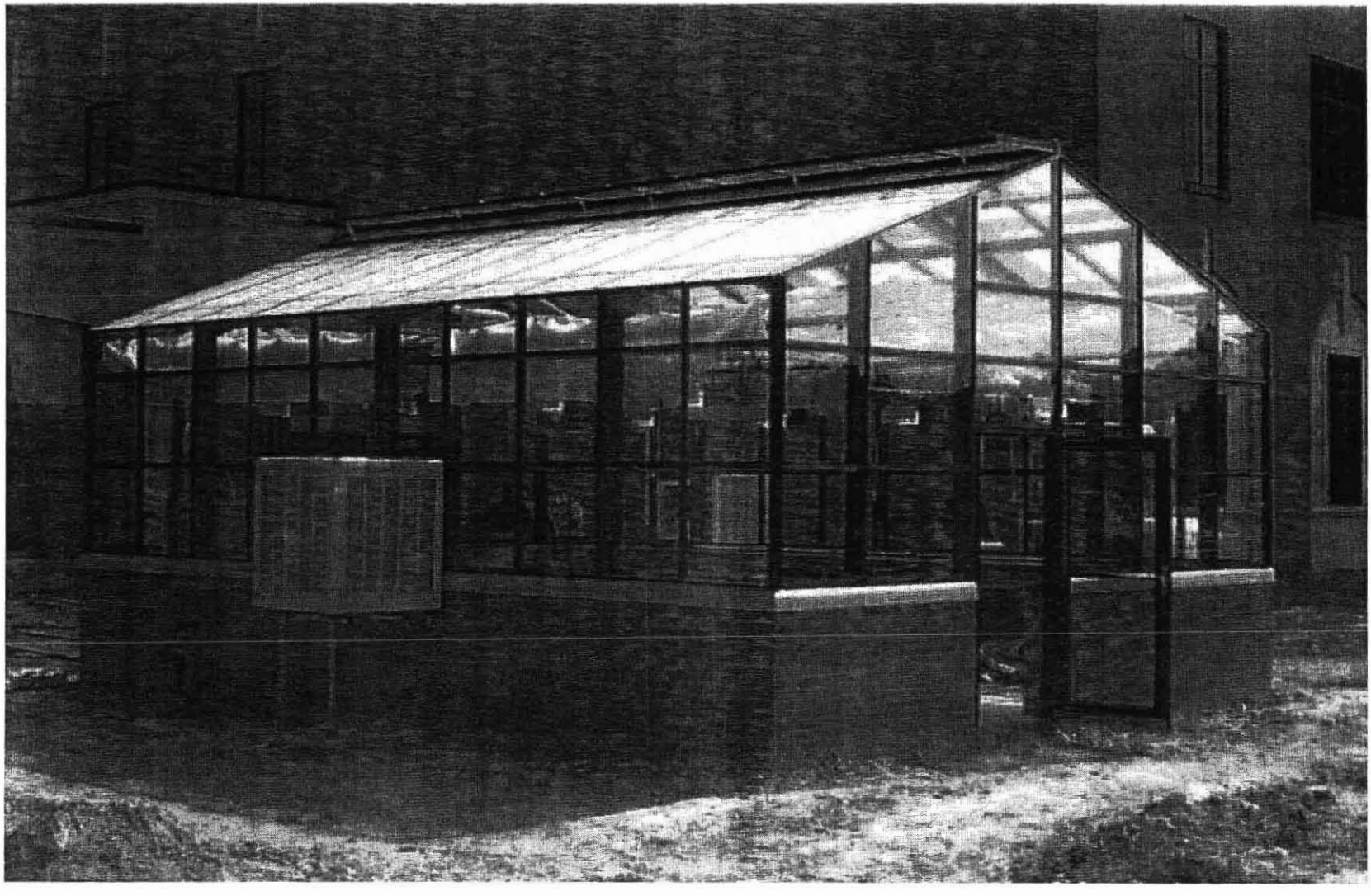
The Penalty

- **$5K first week + $10K each subsequent**
- **Failure to perform inspections**
  - **$305K for 31 weeks of violation Failure to perform compaction tests**
  - **$835K for 84 weeks of violation**
  - **Contractor pays – DOE responsible for legal agreements and for satisfying EPA**

Mitigating the Penalty

- **Propose Two Supplemental Environmental Projects (SEP)**
  1. **Fund local University and Tribe to construct greenhouse for native plants and seeds**
     - **Both quantity and number of species very limited**
     - **Critical and persistent need for revegetation**
  2. **Provide two boats for emergency response**
     - **Two-thirds of county bordered by Columbia River**
     - **Limited ability to respond to spills**
     - **Forms local agency team to respond**

Fund Local University and Tribe to Construct Greenhouse for Native Plants and Seeds

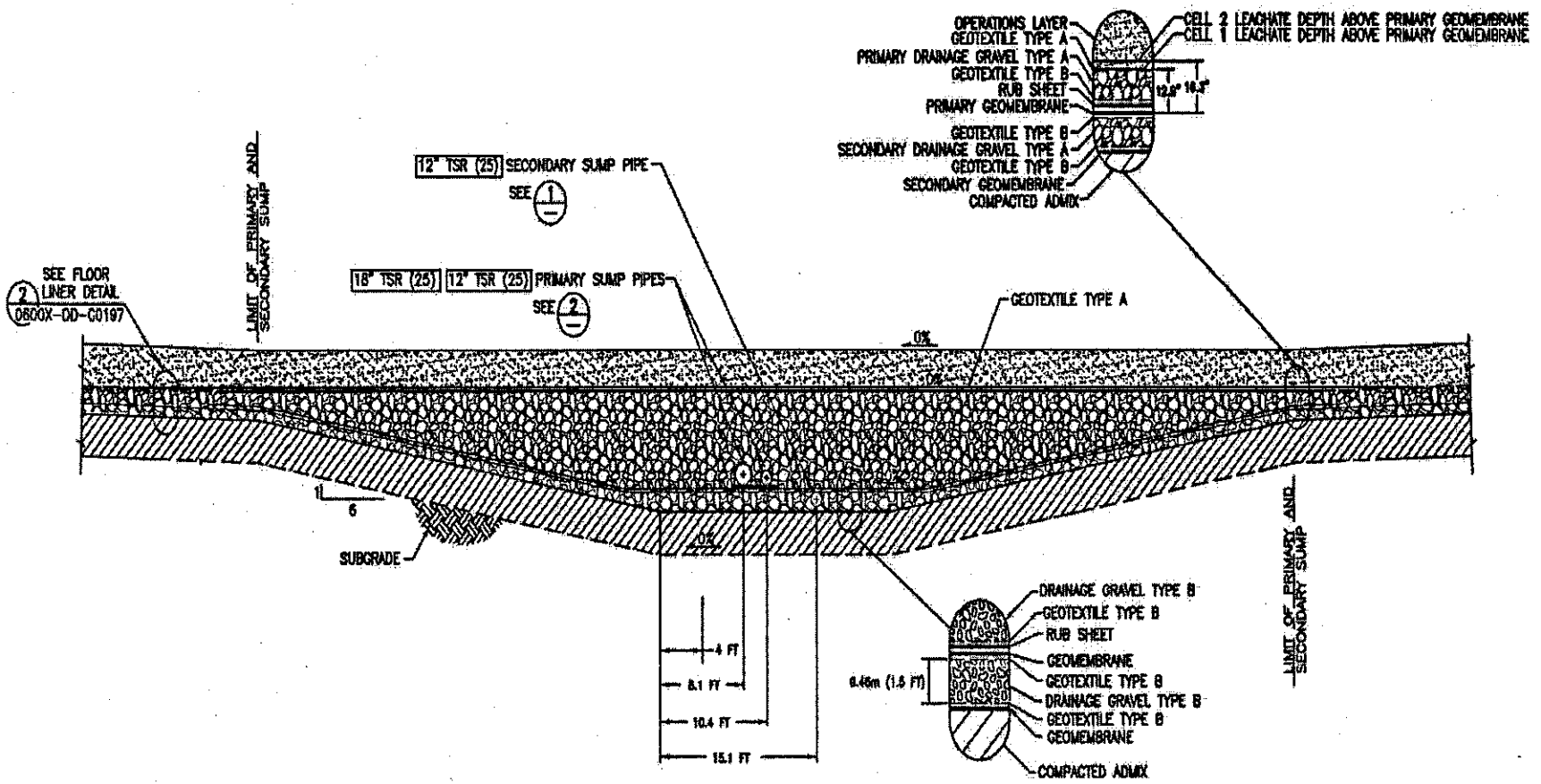


Provide Boats for Emergency Response

Conclusions

- Hanford cleanup and regulatory process both complex
- Agency cooperation makes it work
- Recent failure of disciplined conduct of operations required broad response
- Effort to ensure fine benefits local environment demonstrates cooperation continuing

Sump Detail



A TYPICAL SUMP SECTION
0600X-DD-C0200, C0201 (NOTE 8)